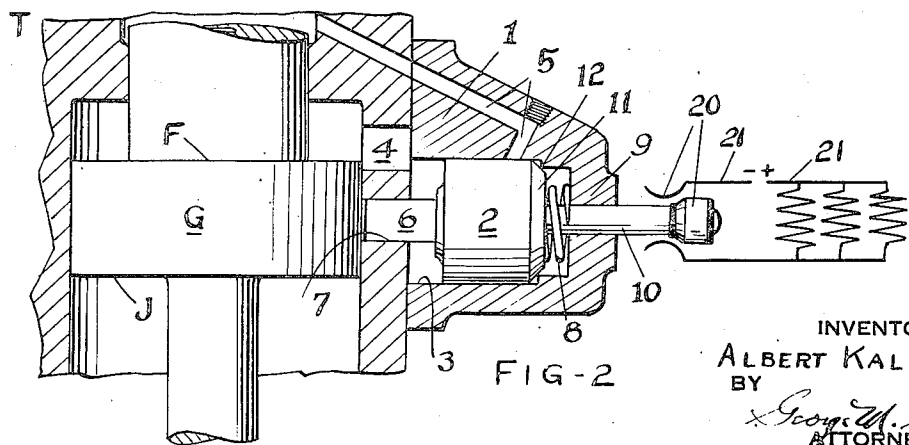
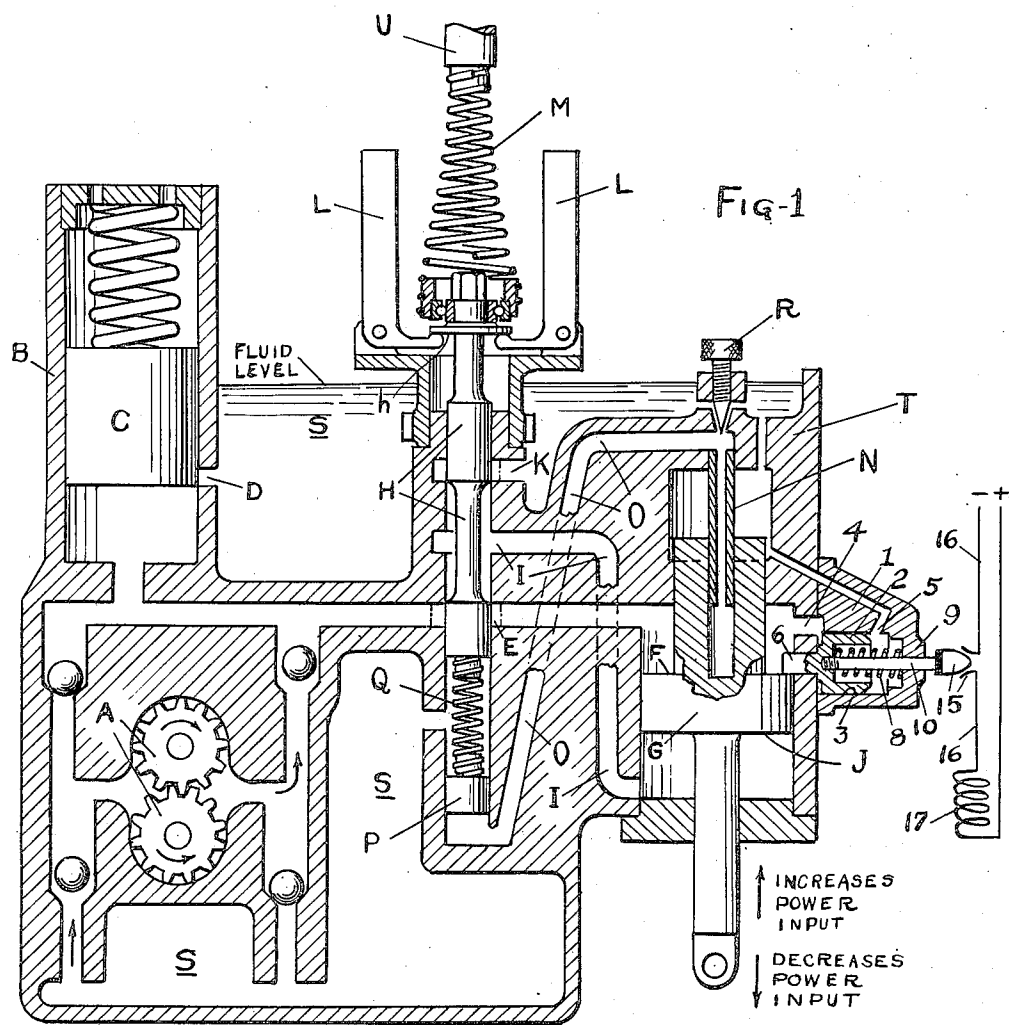


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GOVERNOR

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2,379,304

GOVERNOR

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Original application March 26, 1941, Serial No. 385,228, now Patent No. 2,324,514, dated July 20, 1943. Divided and this application July 24, 1941, Serial No. 403,805

1 Claim. (Cl. 264—14)

This application is a division of my application Serial No. 385,228, filed March 26, 1941, since issued as Patent No. 2,324,514, dated July 20, 1943.

The invention relates to certain improvements in and in combination with governors of the type using a fluid pressure operated servo-motor for regulating, for instance, speed of a prime mover or other machine or apparatus to be governed.

A specific problem solved by the instant invention is in connection with regulating the speed of Diesel engines. When the throttle (fuel injector rack controlling mechanism) is adjusted automatically by a hydraulic servo-motor controlled by engine-speed-responsive means including a pilot valve the usual tendency, upon starting up of the engine, is for the servo-motor to move the throttle rapidly to fully open position. Therefore during starting there is a tendency on part of an engine so governed to overspeed or race as it passes through normal speed during the starting period. This tendency can be obviated by causing the injectors to be stopped at part fuel setting until full speed is reached, at which point fuel restraint is removed and the engine made immediately able to carry full load if necessary. The above indicates one object hereof.

Another object of the present invention is to provide a hydraulically actuated governor having means acting temporarily to restrain the initial movement of the regulating servo-motor to less than its full stroke at commencement of operation of the governor.

Another object is to provide a speed governor wherein speed responsive means and a regulating servo-motor of the governor cooperate during the initial or starting operation of a governed prime mover to restrain servo-motor operation to less than a full stroke thereof in one direction until the prime mover is running in a normal manner—that is independently of extraneous starting force.

In engine-generator units certain adjustments in respect to the generator should be effected during starting and/or initial acceleration of the engine and others not effected until the engine has attained running speed. For example the generator should not be loaded until substantially normal running speed is attained. In case of an electric generator it is desirable to force energization of the generator field coils during acceleration and to cease forcing energization thereof after the engine has attained predetermined running speed.

Another object is to provide, in a governor for prime movers, means to perform appropriate ad-

justments during starting of the prime mover and/or when the same begins to run independently of starting force.

Other objects will become apparent from the following description.

In the drawing Fig. 1 is a schematic assembly view of a governor substantially according to my Patent 2,219,229, issued October 22, 1940, incorporating the present improvement in one form including an electric current controlling means; Fig. 2 is a relatively enlarged detail sectional view of the servo-motor restraining mechanism and a different electrical circuit which may be controlled by said mechanism, the elements of the servo-motor and said mechanism being shown in a relative position different from that shown in Fig. 1.

The principal parts of the illustrative governor mechanism are indicated by letters; the special subject matter hereof by numerals.

Referring to the general arrangement of governor elements, a gear pump A is shown with a well known check valve system and ducts arranged to enable the pump to draw hydraulic fluid from a sump S and deliver it to an accumulator B having a spring loaded plunger C and discharge vent D which cooperate to keep the pressure in the accumulator at constant positive value. The pump is suitably connected to the engine or other machine to be governed. Fluid from the accumulator is supplied to a governor port E and continuously therebeyond to one face F of a double acting hydraulic servo-motor power piston G. The port E is controlled by a lower land portion of a pilot valve plunger H which, if moved downwardly from the normal position in which shown, opens the port E to a duct I leading to the opposite (effectively larger) face J of the power piston, causing upward movement of the piston. Upward movement of the pilot valve plunger from its normal position causes an upper land portion thereof to open the duct I at a port K, dumping pressure fluid from below the power piston into the sump and causing the piston to descend by reason of the constant pressure maintained at the piston face F.

The pilot valve plunger H is moved vertically in opposite directions as a result of the difference between centrifugal force on a set of fly-balls L rotated by the prime mover and opposing force exerted by an adjustable speeder spring M, so that an increase in speed on part of the prime mover raises the pilot valve plunger and a decrease in speed lowers said plunger. Regulation of speed by the servo-motor incident to

change in load is initiated by such movement of the pilot valve plunger H.

Power input to the governed prime mover is increased by raising the power piston G (and decreased by lowering the piston) as indicated on the drawing. Thus, in governing, for example, a Diesel engine, increase in load causes decreased centrifugal force on the fly-balls and lowering of the pilot valve plunger, thus initiating an increase in the rate of supply of fuel to the engine; and decrease in load causes raising of the pilot valve plunger and consequent decrease in the rate of supply of fuel.

An arrangement such as thus far described requires stabilization in order to prevent vacillation in speed or hunting consequent upon load change and subsequent speed-correcting operation of the governor. The stabilizing mechanism includes a hydraulic compensation system supplied with fluid from the sump and actuating and receiving compensation pistons of said system operating as a function of regulating movement of the servomotor piston G to damp or check each movement of said piston and prevent temporary overregulation of the prime mover thereby.

The actuating compensation piston N works in a trunk portion of the power piston G and displaces hydraulic fluid in a duct O leading to the receiving compensating piston P, slidably mounted in a cylindrical extension of the outer pilot valve element, whenever the power piston G starts to perform a regulating operation in either direction. The space above the trunk portion of the power piston is open to the sump through an upper wall portion of the power cylinder block. The motion of the receiving compensation piston P is always opposite the regulation-initiating movement of the pilot valve plunger H, and places temporary primary yielding compensating restraint on each movement of said valve plunger through the intermediary of a coil spring Q connecting the compensating piston P and valve plunger H. The primary compensating force is removed, after regulation is effected, by relieving the positive or negative pressure in the duct O through an adjustable secondary compensation leak-off needle valve R communicating the duct O with the sump.

As fully explained in my Patent 2,219,229 the fly-balls cause continuous rotation of the pilot valve plunger in its coating fixed valve sleeve through contact of the ball-arm fingers with a disc portion h of the plunger; and the spring Q is so connected with the plunger and receiving compensation piston P that the piston is likewise rotated in its fixed cylinder. This eliminates the possibility of binding of either the valve plunger or said piston due to foreign matter in the hydraulic fluid and assures that the pilot valve is free from friction and therefore free to respond to very slight changes in speed. The spring also allows relative axial movement between the parts connected thereby so that the valve is always free to respond promptly to any change in centrifugal force acting on the fly-balls.

In operation, when the engine load is increased the resultant decrease in speed causes relative inward movement of the fly-balls; lowering of the pilot valve plunger; opening of the port E; admission of hydraulic fluid through duct I to the lower side of the power piston G, and increase of fuel to the engine. The upward movement of the piston G pumps fluid through duct O; raising the receiving compensation piston P; compressing the spring Q and exerting an upward slight force on

the pilot valve plunger sufficient to offset the temporary overbalance of speeder spring force relative to the centrifugal force on the fly-balls, thus closing the port E. The port E is ordinarily closed sufficiently quickly to prevent overtravel of the power piston in the speed correcting direction; and, as the engine returns to normal speed, the compression force of the spring Q is dissipated by reason of leakage of fluid from the duct O into the sump through the secondary compensation leak-off aperture of the needle valve R.

The mechanism operates the same as described above for a decrease in load except that all the movements are reversed—the compensating spring Q being placed in tension by suction action of the compensation fluid system, and hydraulic fluid being finally drawn from the sump into the duct O through the aperture of the needle valve R to relieve said tension.

Speed adjusting or changing means is represented by the speeder plug U at the upper end of the speeder spring M. Additional speed changing means would, of course, be provided, for example as in my Patent No. 2,324,514 of which this application is a division, or in other ways as well known in the art. The fly-balls, speeder spring and adjusting mechanism for the latter constitute one example of "speed weighing" means as referred to in the claims hereof and the pilot-valve-controlled hydraulic servo-motor one example of speed regulating means as referred to.

Shown at the right, Figs. 1 and 2, and mounted as by screws (not shown) on the servo-motor block. T is a body 1 constituting a guide and working chamber for a hydraulically actuable plunger or piston element 2 movable transversely of the direction of movement of the power piston G of the servo-motor. One end of the cylinder bore 3 in the body 1 for the plunger 2 is open to the servo-motor cylinder space lying above the power piston G in various lowered positions of the power piston, as through a suitable passage 4 in the servo-motor cylinder block. The opposite end of the bore 3 can be vented to the sump, as above the trunk portion of the power piston, through a suitable passage 5. The plunger 2 works in snug sliding contact with its cylinder bore, and has a reduced portion 6 extending through a guiding opening 7 in the servo-motor block so that the reduced portion can abut the top face of the piston G as a latch, as illustrated in Fig. 1. A coil spring 8 lies partly in an axial cavity of the plunger 2 and reacts against an end wall 9 of the body 1 in a manner to force the latch portion 6 inwardly into latching or blocking abutment with the piston G. The plunger 2 is located at whatever point along the servo-motor cylinder it is desired to arrest the power piston in its initial power-input-increasing or upward stroke, and may, of course, be disposed at any desired point circumferentially of the power cylinder.

As shown the plunger 2 is arranged to stop the power piston at about half way between the limits of its stroke, or when the throttle mechanism controlled by the power piston is half open. Constant pressure fluid from the accumulator operates to withdraw the latch portion 6 of the plunger 2 from power-piston-blocking or latching position, counteracting the force of the spring 8, as more fully explained below, after the engine has been fully started.

Assuming that the engine to be governed is cold and has been standing idle for several hours, it will readily be seen that only negligible fluid

pressure will exist in the accumulator and connected ducts leading to the top face of the power piston G. The power piston will of course be in its lowest possible position in the power cylinder as a result of previous shutting down of the engine. Upon restarting of the engine the first operation of the pilot valve H under speeder spring pressure thereon is to admit hydraulic pressure to the lower face J of the power piston, tending to cause the power piston to move to the full limit of its power input increasing or upward stroke. The upward travel normally is arrested only when the fly-balls L have been moved by centrifugal force to the vertical position in which shown or in position to close both ports E and I by adjustment of the pilot valve. Until nearly normal speed on part of the engine is attained and the accumulator B is charged, there is very little pressure at either working face of the power piston. However there is enough to cause movement of the power piston to full throttle position in the absence of some means to prevent or check such movement.

The spring 8 of the plunger 2 has sufficient force to overcome the initial pressure force on the left hand end of the plunger 2 during the first upward stroke of the power piston G. Therefore the power piston is positively stopped intermediately of full throttle position when the upper face F of the power piston engages the latch portion 6 of the plunger. As the engine picks up speed the preponderance of pressure force continues to be exerted on the lower face J of the power piston, the effective force increasing as the accumulator becomes charged, wherefore the power piston continues to hold the latch in the position shown in Fig. 1 until normal or set speed on part of the engine has been attained. In other words friction on the lower side of the latch portion of the plunger 2 prevents the increasing accumulator pressure from moving the latch to withdrawn position (Fig. 2) until centrifugal force on the fly-balls overbalances the downward force of the speeder spring in holding the pilot valve plunger in depressed position (Port E open to duct I). When the fly-balls finally center the pilot valve plunger H a slight overtravel of the valve plunger opens the port K and the power piston G momentarily descends releasing the friction force on the latch portion 6 of the plunger 2 and allowing constant pressure through the passage 4 (acting also on the free inwardly exposed end of the latch portion 6) to drive the latch back out of the way of the power piston. Thereafter so long as the engine continues to run the plunger 2 remains in the position shown in Fig. 2, and the power piston is free to move upwardly past the latch if required to do so in correcting speed following increase in load.

Since the plunger 2 remains in the position in which shown in Fig. 1 until the engine attains speed and then moves quickly outwardly and stays in the position shown in Fig. 2, the plunger can be used to operate an electric switch such as shown in Fig. 1 at 15 or such as shown in Fig. 2 at 20. One element of each of such switch arrangements as shown can be carried on a pin 10 fixed to the plunger 2 centrally thereof and extending out of the body 1 through a suitable opening for the pin which may be provided with an oil seal (not shown) in case the body 1 is mounted on the outside of the governor case. If the plunger 2 and its guide bore are inside the case, as by forming the guide bore

in the usual sump or power case or the servo-motor block at the usual joint between such case and servo-motor block (construction not illustrated), then the pin 10 would not require any oil seal to prevent leakage nor would special vent ducts to the sump be required as at 5.

While the governor is in operation, after starting, an opportunity for leakage of fluid outwardly along the pin 10 may be prevented by forming a bevel face 11 on the plunger 2 and a circular abrupt shoulder 12 on the interior of the body 1 for coaction therewith as a positive stop valve operable as clearly shown in Fig. 2.

Referring to the switch and circuit arrangement at the right of Fig. 1 the stationary element of the switch 15 is in a conductor 16 leading to a circuit breaker closing coil 17 of a generator driven by the governed engine. With this arrangement since the switch contacts shown are closed only when the engine has been fully started, the load is thrown onto the generator only when starting of the engine has been fully accomplished.

In Fig. 2 the line 21 represents an excitation forcing circuit of a generator driven by the engine, and the switch 20 operates to close the circuit, thus to force energization during acceleration of the engine, and to open the circuit and cease forcing energization after the engine has attained set speed.

In the claim hereof the expression "movable within fixed extreme limits" as applied to the servo-motor is intended to indicate movement of the piston G between the lower and upper ends of its cylinder, and a "complete cycle of operation" on part of the plunger element 2 indicates (a) the operation of the plunger portion 6 in arresting the piston G and (b) the operation thereof (hydraulically performed after mechanical release) of moving clear of said piston as in order to open or close a switch. The idle movement of the plunger back to original position after the governor stops functioning is not considered part of the operating cycle.

Obviously a single plunger 2 can control more than one electric switch or set of switches, for instance, one switch operating as shown in Fig. 1 and one switch operating as shown in Fig. 2.

Irrespective of the type of prime mover governed, the pilot valve and servo-motor would co-operate as described to release and position the device 2, 6 to withdrawn position when full speed is reached; hence the desirable operations as on a generator through use of the device 2, 6 as a switch control is available irrespective of whether or not latching of the power piston temporarily in a particular position is needed.

I claim:

The combination with a hydraulic relay speed governor comprising a pilot valve, speed responsive means controlling the pilot valve and a cylinder and piston constituting a hydraulic servo-motor controlled by the valve and adapted to regulate the speed of a prime mover, of a device normally biased into a position in the path of piston of the servo-motor and engageable by said piston in a manner to cause arrest of the piston intermediately of its possible movement in power-input-increasing direction during an initial stroke of the piston in said direction, and hydraulically operable means acting on said device to move the same to a position clear of said piston consequent upon a partial return stroke of the servo-motor.

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